

Global Models with Chemistry

Model Designed To:

- operate on a global scale
- “**capability**” to simulate atmospheric chemical transformations on this scale

Models may be designed for part of the atmosphere (e.g., stratosphere) with only a rudimentary treatment of the remainder of the atmosphere.

NOAA Atmospheric Chemistry Model Summary

Model Name	Page	Lab	Technical Contact	Forecast	Strat Tropo	Global	Reg Local	Trans Chem	Aerosol Cloud	Output
AM3	11	GFDL	L. Horowitz		✓	✓	✓	✓	✓	Online global trop & strat chem, chemistry-climate interactions
AMTRAC	9	GFDL	J. Austin		✓	✓		✓	✓	Strat O ₃ depletion & recovery, climate change impact on strat chem
Cloud Parcel	47	ESRL	B. Ervens		✓		✓	✓	✓	Cloud chemistry and microphysics
CMAQ	41	ARL	R. Mathur	✓	✓		✓	✓	✓	Regional forecast guidance and assessments for O ₃ , PM, & air toxic distributions
FIM	13	ESRL	S. Benjamin	✓	✓	✓		✓	✓	Global tracer & chem model, under development
FLEXPART	27	ESRL	O. Cooper	✓	✓	✓	✓	✓		Global/regional pollutant transport, source attribution, field mission support
GCTM-Dust	33	GFDL	S.-M. Fan		✓	✓		✓	✓	Global dust transport, acidification, dissolved iron deposition
GFS	15	NCEP	S. Lu	✓	✓	✓		✓	✓	Medium-range weather prediction/ research, boundary conditions for other models
HYSPLIT	31	ARL	R. Draxler	✓	✓	✓	✓	✓	✓	Pollutant transport, dispersion, deposition, forecasting
IDEA	37	NESDIS	S. Kondragunta	✓	✓		✓	✓	✓	PM satellite data assimilation, regional PM forecasting
MAIA	53	ESRL	J. Kazil E. R. Lovejoy		✓	✓	✓	✓	✓	Aerosol formation and growth
MCM Box	51	ESRL	R. Sommariva		✓		✓	✓	✓	Chem mechanism development, plume chem analysis
MOZART	17	ESRL/ GFDL	C. Granier L. Horowitz		✓	✓		✓	✓	Evolution of global chem distributions, observational analysis, assessments
NOCAR	21	ESRL	R. Portmann S. Solomon			✓		✓	✓	Strat O ₃ evolution and depletion potentials, source gas lifetimes
RAMS/ LES	49	ESRL	G. Feingold		✓		✓	✓	✓	Aerosol-cloud interactions
RAQMS	19	NESDIS	R. B. Pierce	✓	✓	✓		✓	✓	Global chem satellite data assimilation & analysis, field mission support
RUC/ CSU-LPDM	35	ESRL	S. Benjamin	✓	✓		✓	✓		Rapid update weather prediction, tracer transport, pollutant source attribution
STILT	29	ESRL	A. Hirsch	✓	✓		✓	✓		Greenhouse gas transport and source analysis
TM5			W. Peters/	✓	✓	✓		✓	✓	Global/regional chem tracer transport, pollutant source & sink analysis
Carbon Tracker	25	ESRL	A. Jacobson							
WRF/Chem	43	ESRL	G. Grell	✓	✓	✓	✓	✓	✓	Regional online forecasting & analysis of O ₃ & PM, climate-AQ interactions

Atmospheric Model with Transport and Chemistry (AMTRAC)

Brief description

- Climate model with coupled stratospheric chemistry and simplified tropospheric chemistry.

Principal applications/customers

- Timing and extent of ozone depletion and recovery.
- Impact of climate change on stratospheric chemistry.

Key participants, lab/organization, effort, contact information

- John Austin, UCAR/GFDL (full time).
- John Wilson, GFDL (part time).

Atmospheric Model 3 (AM3)

Brief description

- General circulation model (GCM) being developed at GFDL. It includes online, interactive tropospheric and stratospheric gas-phase and aerosol chemistry.

Principal applications/customers

- Simulating global- and regional-scale climate and distributions of chemical species.

Key participants, lab/organization, effort, contact information

- Larry W. Horowitz, GFDL, larry.horowitz@noaa.gov.
- Paul Ginoux, GFDL, paul.ginoux@noaa.gov.
- John Austin, GFDL/UCAR, john.austin@noaa.gov.
- John Wilson, GFDL, john.wilson@noaa.gov.
- Yi Ming, GFDL/UCAR, yi.ming@noaa.gov.

Chemistry/aerosols

- **Tropospheric chemistry** scheme and solver based on that in MOZART-2 [Horowitz et al., 2003]
- **Stratospheric chemistry** based on that in UMETRAC [Austin and Butchart, 2003] and AMTRAC
- **Aerosols** based on GOCART [Ginoux et al., 2001; Chin et al., 2002]
- Aerosol-cloud interactions [Ming et al., 2007]

Flow-following finite-volume Icosahedral Model (FIM)

Brief description

- Global 3-D dynamic model under development at ESRL. Icosahedral horizontal grid (avoid pole problem), finite-volume horizontal advection and isentropic-sigma vertical coordinate, GFS precip/radiation/boundary-layer/land-surface physics, **suitable for chemistry in future** (e.g., WRF/Chem schemes).

Principal applications/customers

- Alternative global model for NCEP global ensemble, possible flagship model for ESRL research using ESRL coupled assimilation-modeling on global scale.

Key participants, lab/organization, effort, contact information

- Jin Lee, Rainer Bleck, Jian-wen Bao, Stan Benjamin, John Brown, and Jacques Middlecoff, ESRL GSD/PSD.
- Primary contact – Jin Lee, Stan Benjamin.

Chemistry/aerosols

- **None yet**, future adaptation of WRF/Chem schemes.

Global Forecast System (GFS)

Brief description

- Global spectral model for medium-range weather predictions and atmospheric research.

Principal applications/customers

- Weather forecasts out to 16 days.
- Forecasts routinely used by NWS field offices, other government agencies, the private sector, and the public.

Key participants, lab/organization, effort, contact information

- Sarah Lu, NOAA/NCEP/EMC, full-time, sarah.lu@noaa.gov.
- Ho-Chun Huang, NOAA/NCEP/EMC, full-time, ho-chun.huang@noaa.gov.

Chemistry/aerosols

- **Ozone:** Naval Research Lab (NRL) ozone physics algorithm (production and destruction are parameterized from monthly and zonal mean dataset derived from NRL 2-D ozone chemistry model);
- **Aerosols:** NASA GOCART (**planned activities**).

Model for OZone And Related chemical Tracers (MOZART)

Brief description

- Global chemical transport model, driven with offline meteorology (e.g., NCEP or ECMWF reanalyses, or from a GCM).

Principal applications/customer

- Studies of the evolution of the global distribution of chemical species (gases and aerosols) for present, past (1860-2000), and future (2000-2100) periods. Analysis of observation campaigns. Analysis of satellite data and inverse modeling. Participation in international assessments.

Key participants, lab/organization, effort, contact information

- NOAA: Claire Granier (claire.granier@noaa.gov), ESRL/CSD; Larry Horowitz (larry.horowitz@noaa.gov); Arlene Fiore (arlene.fiore@noaa.gov), GFDL.
- NCAR: L. Emmons (emmons@ucar.edu), P. Hess, J.-F. Lamarque, D. Kinnison, J. Orlando, G. Pfister, X. Tie, G. Tyndall, S. Walters.
- FZ Juelich, Germany: M. Schultz (m.schultz@fz-juelich.de), O. Stein.

Chemistry/aerosols

- MOZART-4 contains 98 chemical species and about 200 chemical reactions; O₃, CO, NO_y compounds, HO_x compounds, several hydrocarbons and their oxidation compounds, SO₂, SO₄⁼, H₂SO₄, black carbon, organic carbon, SOA, DMS. Species and reactions included can be modified easily using chemical pre-processor.

Real-time Air Quality Modeling System (RAQMS)

Brief description

- Online unified troposphere/stratosphere global chemical data assimilation/forecasting system.

Principal applications or customers

- Development of global satellite data chemical data assimilation capabilities; assessment of impacts of lateral boundary conditions, forecasting, and analysis support for airborne field missions.

Key participants, lab/organization, effort, contact information

- R. Bradley Pierce, NOAA/NESDIS/STAR, brad.pierce@noaa.gov.

Chemistry/aerosols

- Family (O_x , NO_y , Cl_y , Br_y) approach with 55 transported species, fast species assume PCE. Standard O_x - HO_x - NO_x - ClO_x - BrO_x cycles governing the formation and destruction of odd oxygen, tropospheric NO_x - HO_x reactions, oxidation of CH_4 , and CO. Treatment of non-methane hydrocarbons (NMHC) based on extended CB IV (explicit treatment of ethane, ethene, and methanol oxidation, semi-explicit treatment of propane) and explicit treatment of isoprene oxidation.

2-D Middle Atmosphere Model (NOCAR)

Brief description

- Coupled dynamical-radiative-chemical two-dimensional model of the middle atmosphere, including detailed ozone chemistry and its interaction with long and short lived gases.

Principal applications/customers

- Evolution of ozone, ozone depletion potentials, lifetimes of source gases.

Key participants, lab/organization, effort, contact information

- Robert Portmann, ESRL/CSD, robert.w.portmann@noaa.gov.
- Susan Solomon, ESRL/CSD, susan.solomon@noaa.gov.

Chemistry/aerosols

- Detailed family approach for stratospheric chemistry.